REMARKS/ARGUMENTS

Reconsideration is respectfully requested of the Office Action of November 18, 2004.

A request for a two month extension of time, together with the associated fee, is filed herewith.

Applicants acknowledge with appreciation the courtesy extended to counsel by Examiner Selby and the Primary Examiner Mr. Tuan Ho at the interview conducted on March 22, 2005. Claim 1 and the *Miura* reference, U.S. patent 4,879,596, were discussed at the interview at the conclusion of which the Examiners agreed that the proposed amendments to Claim 1, adding the limitation of an image processing means for calculating a three-dimensional distance distribution and the limitation of the corresponding area being searched in a striplike search area was not disclosed by *Miura*.

The claims in the case are: 1, 3, 5-7, 9, 10, 13, 16, 21 and 22. Claims 1 and 6 have been amended to further clarify the features of the present invention. New Claims 21 and 22 are presented for the purpose of claiming further detailed aspects of the invention not rendered obvious by the prior art.

The claim amendments are fully supported by the original claims and the specification. No new matter has been added. The Examiner is respectfully requested to reconsider and withdraw the outstanding objections and rejections in view of the remarks contained herein.

Double Patenting (Provisional Rejection)

It is noted that the rejection of Claim 5 under the judicially created doctrine of obviousness-type double patenting has not been repeated and is therefore considered to be withdrawn.

No Issues Under 35 USC § 112.

It is noted that none of the claims have been objected to under 35 U.S.C. § 112.

Claim Rejections – 35 U.S.C. § 103

The following rejections were set forth in the Office Action of November 18, 2004:

1) Claims 1, 3, 5, 9 and 16 were rejected under 35 U.S.C. § 103(a) as allegedly unpatentable over *Miura* (US 4,879,596).

2) Claims 2, 4, 10-13 and 14 were rejected under 35 U.S.C. § 103(a) as allegedly unpatentable over *Miura* (previously cited), in view of *Tanigawa* (US 5,915,033). This rejection is moot with respect to Claims 2, 4, 11, 12 and 14, as these claims have been cancelled.

3) Claim 6 was rejected under 35 U.S.C. § 103(a) as allegedly unpatentable over *Miura,* in view of *Lipton* (US 6,063,441).

4) Claims 7, 15 and 17-20 were rejected under 35 U.S.C. § 103(a) as allegedly unpatentable over *Miura*, in view of *Saneyoshi* (US 5,410,346).

All these rejections are traversed and reconsideration is respectfully requested in view of the foregoing amendments.

The rejections of Claims 2, 4, 11, 12, 14, 15 and 17 to 20 are rendered moot by cancellation of these claims.

By this response, Claim 1 has been amended as follows:

1. (Currently Amended) A stereo camera apparatus comprising:

a main camera for taking a photograph of an object; and

a sub-camera for taking a photograph of said object from a point of view different from a point of view of said main camera, said main camera and said sub-camera being disposed with respect to each other by a predetermined spacing,

a shooting direction of said stereo camera is substantially perpendicular to said predetermined spacing in a baseline between the main camera and the sub-camera,

image processing means for calculating a three-dimensional distance distribution of said object based on a positional difference between a region in a reference image photographed by said main camera and a corresponding area in a comparative image photographed by said sub-camera to an image signal of said region,

wherein said corresponding area is searched in a striplike search area having a predetermined length which extends from a position substantially corresponding to said region, said positional difference is obtained from an area which is capable of setting said search area inside of said comparative image,

wherein optical axes of said main camera and said sub-camera are inclined toward the main camera side with a predetermined angle with respect to the shooting direction defined by each of the optical axes and the shooting direction,

wherein angles of inclination of said main camera and said sub-camera are set to be such angles that said three-dimensional distance distribution is substantially left-right symmetric with respect to the shooting direction.

Applicants submit that Claim 1 is not suggested, taught or hinted at in *Miura* and accordingly *Miura* fails to establish prima facie obviousness of the claimed invention.

The camera structure of *Miura* provides for one camera that can be rotatably adjusted in an up-down direction (vertical direction), and the other camera can be rotatably adjusted in a left-right direction (horizontal direction), and both cameras can be rotatably adjusted with an optical axis of each camera as a center of rotation. This is clear from the fact that the reference shows that the cameras can be adjusted by loosening the screws fitted in the elongated apertures; see col.3, lines 50, et seq.

It appears from page 3 of the Office Action that the *Miura* reference is understood to show both cameras can be adjusted in left-right direction. Specifically, the Office Action considers *Miura* as showing each camera can be rotatably adjusted with its optical axis as a center of rotation and that each camera can be adjusted in a left-right direction.

Considering only the description in col. 3, lines 62-65, and col. 4, lines 7-9, of *Miura* that is referred to on page 3 of the November 18, 2004 Office Action, it could be interpreted that the optical axes of both cameras can be adjusted in left-right direction. However, a closer study of the reference in its entirety shows that each camera is rotatably adjusted with its optical axis as a center of rotation.

As shown in the description in col. 3, line 51, to col. 4, line 9, of *Miura*, the arrows "E" or "F" show the adjustment direction in Fig. 4b. This shows an adjustment direction of camera 20a by movement of screws 82, 84 within the elongated holes 86, 88, and also shows an adjustment direction of camera 20b by movement of screws 100, 102 within the arch shaped elongated hole (not shown). Thus, even if the cameras are adjusted in this "E" or "F" adjustment

direction, the optical axis of camera is always parallel with the shooting direction and not as defined in Claim 1 herein; namely, inclined toward the main camera side with a predetermined angle with respect to the shooting direction defined by each of the optical axes and the shooting direction.

Please note that an adjustment of the optical axis in left-right direction in *Miura* is made in the "C" or "D" direction as shown in Fig. 3A.

Miura does not disclose that both cameras can be adjusted in left-right direction, and does not suggest that optical axes of both cameras be inclined toward the main camera side with a predetermined inclination angle with respect to the shooting direction or vehicle central axis.

The rejection of Claims 1, 3, 5, 9 and 16 under 35 U.S.C. § 103(a), in view of *Miura*, is traversed and reconsideration is respectfully requested.

The Official Action admits that *Miura* does not show that the optical axes of the two cameras are inclined toward the main camera side at a predetermined angle defined by the optical axes and the shooting direction.

Not only that, but the *Miura* reference also does not obtain a three-dimensional distance distribution by image processing (stereo matching) as defined in the present invention. In addition, *Miura* does not disclose searching the corresponding area in a striplike search area as defined in Claim 1. According to *Miura*, the operator is able to see the three-dimensional distance distribution by using the liquid crystal shutter glasses (3-D glasses).

However, to obtain the high-precision three-dimensional distance distribution by the image processing (stereo matching), the three-dimensional distance distribution can be obtained only in a part of the region imaged by both cameras. In this structure, it is difficult to specify the

region of the comparison image that coincides with the small region of the reference image, and there is no choice other than the process that the region with the highest coincident region among plural candidates is judged as the coincident region.

More specifically, in the stereo matching, the correlation value is calculated for every shift while sequentially shifting the small region in the reference image with respect to the predetermined search area in the comparison image. Then, the calculated correlation values are compared with each other, and the shift amount which has the highest correlation value is defined. Therefore, it is important to obtain the predetermined length search area in the comparison image.

There is no reason, motivation or suggestion for a person skilled in the art to change or modify the *Miura* system to include the features of the inclined optical axes, image processing means for calculating a three dimensional distance distribution and searching a striplike search area. Therefore, *Miura* clearly fails to establish *prima facie* obviousness of the subject matter of Claim 1.

Claims 3, 5, 9 and 16 depend from Claim 1 and define further features of the invention. In view of the fact that *Miura* fails to establish *prima facie* obviousness for the subject matter as explained above, applicants submit that, likewise, *Miura* fails to establish *prima facie* obviousness for the subject matter of Claims 3, 5, 9 and 16.

With regard to dependent Claim 3, this claim has a feature such that the optical axis of the sub-camera is inclined toward the sub-camera side with respect to the optical axis of the main camera. In col. 1, lines 39-47, of *Miura*, each of the cameras needs to be adjusted about its optical axes so that left and right cameras images coincide with each other on an "imaginary

plane" in the predetermined distance. In contrast, the present invention performs the adjustment so that the left and right cameras images do not coincide with each other on "imaginary plane" in the predetermined distance. Thus, *Miura* does not suggest the above-mentioned features of the present invention.

Applicants further note that dependent Claims 3 and 9 have an optical axis of the sub-camera that is inclined toward the sub-camera side with respect to the main camera, which is not disclosed or suggested in any of cited references.

Miura does not disclose a structure that both cameras are inclined to left or right together, but discloses that one of cameras is inclined to left or right so that the predetermined convergence angle is obtained. Moreover, *Miura* does not disclose or suggest the above-mentioned feature of "the optical axis of the sub-camera is inclined toward the sub-camera side with respect to the optical axis of the main camera" in Claim 3.

Dependent Claim 16 specifies that the "angles of inclination of said main camera and said sub-camera are set to be such angles that make an area substantially left-right symmetric with respect to a central axis of a vehicle parallel to the shooting direction, said area being an area of three-dimensional distance distribution obtained by an image processing unit on the basis of images photographed by said cameras".

The Office Action sets forth that Figure 6 of *Miura* discloses that if the shooting direction and the central axis of the vehicle coincide with each other, the three dimensional distance distribution becomes inherently left-right symmetric.

Applicants, however, contend that *Miura* performs the detection in an area where the reference and comparison images coincide with each other based upon someone's judgment

using the liquid crystal shutter spectacles. In contrast, the present invention has a device that detects the corresponding area, i.e. an image processing device.

The rejection of Claims 10 and 13 under 35 U.S.C. § 103(a) in view of *Miura*, taken with *Tanigawa* (US Patent 5,915,033), is traversed and reconsideration is respectfully requested.

Miura is discussed above and all comments apply with equal emphasis to the rejection of Claims 10 and 13.

Although the *Tanigawa* reference discloses that the three-dimensional distance distribution can be obtained by the image processing (stereo matching), *Tanigawa*'s system is different from the image processing (stereo matching) recited in Claim 1, upon which Claims 10 and 13 ultimately depend.

Thus, the stereo matching of *Tanigawa* divides the reference image and the comparison image into a window frame WDl and the window frame WD2, respectively. The window frame WDI of the reference image and the window frame WD2 of the comparison image have the same region.

On the other hand, the present invention as now defined specifies that the search area set in the comparison image with respect to the small region of the reference image extends in a striplike shape from the position corresponding to the small region.

Tanigawa does not disclose or suggest the structure where the search area set in the comparison image extends in a striplike shape from the position corresponding to the small region.

Thus, the cited combination of *Miura* and *Tanigawa* do not disclose the following features defined in the claims of the present application:

(a) optical axes of both cameras are inclined toward the main camera side with a predetermined inclination angle with respect to the shooting direction;

(b) image processing means for calculating a three-dimensional distance distribution of the object based on a positional difference between a region in the reference image and a corresponding area in the comparative image; and

(c) search area set in the comparison image extends in a striplike shape from the position corresponding to the small region.

As noted above, the stereo matching of *Tanigawa* divides the entire area of the reference image with the window frame WD1 having the same area as the window frame W01 of the comparison image, and calculates the parallax for every window frame WDI. The three-dimensional distance distribution obtained in the reference image by using this method, can be obtained for the entire area of the reference image, and it does not displace toward the comparison image as shown in the present invention. In other words, the three-dimensional distance distribution obtained without the inclination of the optical axis of the camera with respect to the shooting direction can be left-right symmetric with respect to the shooting direction.

However, if the window frame WD1 of the reference image is set to have the same area as the window frame WD2 of the comparison image as shown in *Tanigawa*, the number of the sensor data that the window frame WD1 includes is increased. Since only one parallax is obtained for each window frame WD1 in the stereo matching of *Tanigawa*, if the window frame WD1 includes many sensor data, these sensor data are considered to have the same

parallax. Therefore, the parallax obtained for each window frame WD1 is of low precision and, thus, the three-dimensional distance distribution is of low precision.

On the other hand, in the present invention, the search area of the comparison image extends from the position corresponding to the small region, and optical axes of both cameras are inclined towards the main camera side with the predetermined inclination angle with respect to the shooting direction. Thus, the present invention has an effect that the high precision three-dimensional distance distribution can be obtained while reducing the number of sensor data which are considered to have the same parallax, and the three-dimensional distance distribution can be made left-right symmetric with respect to the shooting direction.

There is no reason, suggestion or motivation in either *Miura* or *Tanigawa* whereby a person skilled in the art would be lead to change or modify the *Miura* system and to thereby arrive at the present invention. Therefore, no *prima facie* obviousness has been established.

Dependent Claims 9, 10 and 13

The common feature of dependent Claims 9, 10 and 13 is that the sub-camera is inclined toward the sub-camera side with respect to the optical axis of main camera. With this structure, an infinite distance corresponding point with respect to a small region located in an image end portion of the reference image can be obtained with certainty in the comparison image.

Miura discloses that an optical axis of one of two cameras is adjusted so as to obtain a predetermined convergence angle defined by the intersection of the optical axes of the cameras. Therefore, the adjustment of the *Miura* cameras is not performed with the structure as defined by the present claims under any circumstances.

Claims 10 and 13 have a feature that a search margin is provided for searching an infinite distance corresponding point corresponding to a small region located near the end of the reference image. This feature is not disclosed in any cited reference.

Miura shows a structure wherein the optical axis of one of two cameras is adjusted so as to obtain a predetermined convergence angle defined by the intersection of the optical axes of the cameras. With such an adjusted angle, if there is a variation in imaging areas of the respective cameras due to manufacturing error, an infinite distance corresponding point corresponding to the small region located at the end of the reference image does not exist within the comparison image, and, thus, the parallax of the infinite distance corresponding point cannot be calculated.

The correction of deviation in the *Tanigawa* device is accomplished in that the calculated parallax is corrected based on the correction coefficient corresponding to the deviation between the position of a region in a reference image and the position of its corresponding region in the comparison image.

With this structure of the *Tanigawa* reference, the correct parallax can be obtained by the above-mentioned correction it the coincident region can be defined correctly. However, even if this correction is made, if there is the variation in imaging areas by both cameras, the parallax of an infinite distance corresponding point corresponding to the small region located at the end of the reference image cannot accurately be calculated. In other words, if the deviation occurs in an optical axis direction of each camera due to an error in assembly, and thus, an infinite distance corresponding point corresponding the small region of the reference image does not exist within the comparison image, the parallax of the infinite distance corresponding point cannot be

calculated because the different region which is not the proper coincident region is defined mistakenly as the coincident region.

On the other hand, since the present invention provides the search margin for searching an infinite distance corresponding point corresponding to the small region located at the end of reference image, the present invention has an effect that the infinite distance corresponding point corresponding to the small region located at the end of the reference image can accurately exist within the comparison image, and thus parallax can be accurately calculated.

In *Miura*, even if the main camera captures the target object on the main camera side, outside of the viewing area of the sub-camera, the optical axes of both of cameras are not inclined towards the main camera side as required in the present invention. In the present invention, the effect obtained by the above-mentioned feature, as described in page 11, lines 4-9, of applicants' specification, is obtaining the three-dimensional distance distribution having left-right symmetry with respect to the shooting direction can be obtained. *Miura*, however, does not disclose the above-mentioned features and the resulting benefits obtained thereby.

Applicants contend that *Miura* has a structure having an optical axis of the sub-camera that is inclined towards the main camera side with respect to the optical axis of the main camera, contrary to the present invention, and that the infinite distance corresponding point which corresponds to the small area at edge of the reference image does not exist within the comparison image.

According to applicants, the secondary reference, *Tanigawa*, discloses that by assembling errors of each of the cameras, a deviation occurs between the position of the area in the reference image and the position of the corresponding area in the comparison image. With the correction

coefficient previously specified by taking the deviation into the consideration, a correction is performed for the calculated parallax so that the parallax can accurately calculated.

In the *Tanigawa* device, after searching the area where the image data coincide with each other, the correction is performed in the calculation of the parallax, and thus, when the area where the image data coincide with each other can not be searched, and the parallax cannot be correctly calculated even if the correction is performed. That is, if the indefinite distance corresponding point which corresponds to the small area at the edge of the reference image does not exist within the comparison image due to the assembling errors of the stereo camera, the parallax of the infinite distance corresponding point can not be calculated.

In contrast, the present invention has a structure that by inclining the optical axis of sub-camera towards the sub-camera side with respect to the optical axis of the main camera, the infinite distance corresponding point which corresponds to the small area at edge portion of the reference image can surely exist within the comparison image, and thus, the infinite distance corresponding point can be detected even if the there are the assembling errors.

Further, applicants note that in Claims 10 and 13, the indefinite distance corresponding point which corresponds to the small area at the edge of the reference image can be detected. These claims have a feature such that in order to detect the infinite distance corresponding point, the optical axis is inclined toward the sub-camera side with respect to the optical axis of the main camera.

Further, based on the description in page 8, lines 8-21 and Figure 4, new dependent Claim 21 defines that the search area is longer than the length of the small region of the reference image.

The inclination amount of both cameras and the structure that the three-dimensional distance distribution becomes left-right symmetric with respect to the shooting direction by including the camera which is now defined in new Claim 22 is not rendered prima facie obvious by the combination of references.

More specifically, based on the description from page 9, line 21 to page 10, line 8 and Figure 2D, Claim 22 recites the inclination angle of both cameras is an angle corresponding to a displacement between a line for setting the three-dimensional distance distribution generating area on the reference image substantially symmetrical on the left and right sides and a vertical line perpendicular to the optical axis of the main camera on the reference image. This feature is neither shown nor suggested by the cited prior art.

With regard to the additional citations of *Lipton* (US 6,063,441) and *Saneyoshi* (US 5,410,346) and the rejections of Claims 6 and 7, these claims depend on Claim 1 and the discussion of *Miura* above applies with equal emphasis here.

The *Lipton* and *Saneyoshi* references would not lead persons skilled in the art to make changes or modifications to the *Miura* system with the expectation of a desirable result that would fall within the scope of the rejected claims.

CONCLUSION

Applicants respectfully submit that this amendment and the above remarks obviate the outstanding objections and rejections in this case, thereby placing the application in condition for immediate allowance. Allowance of this application is earnestly solicited.

Respectfully submitted,

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